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(54) POWER SUPPLY DEVICE

STROMVERSORGUNGSVORRICHTUNG

DISPOSITIF D'ALIMENTATION ÉLECTRIQUE

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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a power supply device.

2. Description of the Related Art

[0002] As a power supply device, for example, Japanese Patent Application Laid-open No. 2018-33263 has described a quick charging device which includes a first battery module and a second battery module, and connects the first and second battery modules in series or in parallel when charging and discharging the first and second battery modules.

[0003] It has been desired that the above-mentioned quick charging device described in Japanese Patent Application Laid-open No. 2018-33263 can be properly charged when the first and second battery modules are connected in parallel in a state where the charging rates of the first and second battery modules are different, for example.

[0004] Patent document DE 10 2016 008052 (A1) discloses a power supply device with two battery modules and a plurality of switches for connecting the battery modules in either one of a series configuration and a parallel configuration.

[0005] The present invention has been made in view of the above, and an object of the present invention is to provide a power supply device capable of properly charging and discharging.

[0006] This is achieved by the features of the independent claim. Preferred embodiments are the subject matter of the dependent claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007]

FIG. 1 is a schematic diagram illustrating a configuration example of a power supply device according to an embodiment;
FIG. 2 is a schematic diagram illustrating a configuration example of a part of the power supply device according to the embodiment;
FIG. 3 is a schematic diagram illustrating a configuration example of a series circuit according to the embodiment;
FIG. 4 is a schematic diagram illustrating a configuration example of a parallel circuit according to the embodiment;
FIG. 5 is a circuit diagram illustrating a configuration example of a part of the power supply device according to the embodiment;
FIG. 6 is a circuit diagram illustrating a configuration example of a voltage monitor circuit according to the embodiment;
FIG. 7 is a circuit diagram illustrating a configuration example of a voltage monitor circuit according to the embodiment;
FIG. 8 is a flowchart illustrating an operation example of 400 V charging according to the embodiment; and
FIG. 9 is a schematic diagram illustrating a configuration example of a power supply device according to a modification of the embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0008] Some modes (embodiments) for carrying out the present invention will be described in detail with reference to the drawings.

Embodiments

[0009] A power supply device 1 according to an embodiment will be described with reference to the drawings. FIG. 1 is a schematic diagram illustrating a configuration example of a power supply device 1 according to an embodiment. FIG. 2 is a schematic diagram illustrating a configuration example of a part of the power supply device 1 according to the embodiment. FIG. 3 is a schematic diagram illustrating a configuration example of a series circuit P according to the embodiment. FIG. 4 is a schematic diagram illustrating a configuration example of a parallel circuit Q1 according to the embodiment. FIG. 5 is a circuit diagram illustrating a configuration example of a part of the power supply device 1 according to the embodiment. FIG. 6 is a circuit diagram illustrating a configuration example of a voltage monitor circuit 61 according to the embodiment. FIG. 7 is a circuit diagram illustrating a configuration example of a voltage monitor circuit 63 according to the embodiment.

[0010] The power supply device 1 is mounted on a vehicle and supplies power to load units such as a front power control unit (PCU) 3 and a rear PCU 4 provided in the vehicle. The vehicle is, for example, an electric vehicle such as an electric vehicle (EV), a hybrid electric vehicle (HEV), or a plug-in hybrid electric vehicle (PHEV). In the power supply device 1, for example, a connector of an external charger is connected to a 400 V inlet 21 of a vehicle, and a battery unit 10 is charged with power supplied from the external charger via the 400 V inlet 21. The power supply device 1 supplies the charged power to load units such as the front PCU 3 and the rear PCU 4. Hereinafter, the power supply device 1 will be described in detail.

[0011] As illustrated in FIGS. 1 to 5, for example, the power supply device 1 includes a battery unit 10, a 400 V inlet 21 as an input unit, a main switching unit 30, a charge switching unit 40, a battery switching unit 50 as a switching unit, and a controller 60.

[0012] The battery unit 10 is an assembly of storage

batteries capable of charging and discharging DC power. The battery unit 10 is configured to include, for example, a first battery 11 and a second battery 12. The first battery 11 is a storage battery capable of charging and discharging DC power and has a plurality of battery cells. Each battery cell is constituted of a secondary battery capable of charging and discharging, and is constituted of, for example, a lithium ion battery. Each battery cell is connected in series with an adjacent battery cell.

[0013] The second battery 12 is constituted in the same manner as the first battery 11. In other words, the second battery 12 is a storage battery capable of charging and discharging DC power, and has a plurality of battery cells. Each battery cell of the second battery 12 is constituted of a secondary battery capable of charging and discharging, and is constituted of, for example, a lithium ion battery. Each battery cell of the second battery 12 is connected in series with an adjacent battery cell. The second battery 12 has the same discharge capacity as the first battery 11.

[0014] The battery unit 10 is switched to a series circuit P (see FIG. 3) connecting the first battery 11 and the second battery 12 in series, or a parallel circuit Q1 (see FIG. 4) connecting the first battery and the second battery in parallel. The battery unit 10 is connected to an external charger while being switched to the series circuit P or the parallel circuit Q1, and charges power supplied from the external charger. The battery unit 10 is also connected to the front PCU 3 and the rear PCU 4 while being switched to the series circuit P, and supplies the charged power to the front PCU 3 and the rear PCU 4.

[0015] A charging inlet 20 is a charging port for inputting power supplied from an external charger. The charging inlet 20 is configured to include a 400 V inlet 21 and an 800 V inlet 22 as input units (see FIG. 1). The 400 V inlet 21 corresponds to an external charger having a voltage of 400 V. The 400 V inlet 21 is connected to the battery unit 10 via the charge switching unit 40 (charging relay 41, parallel-connected relay 51). The 400 V inlet 21 is electrically connected to an external charger when the connector of the external charger is inserted, and inputs power supplied from the external charger. The 400 V inlet 21 outputs the inputted power to the battery unit 10 via the charge switching unit 40.

[0016] The 800 V inlet 22 corresponds to an external charger having a voltage of 800 V. The 800 V inlet 22 is connected to the battery unit 10 via the charge switching unit 40 (charging relays 43 and 44). The 800 V inlet 22 is electrically connected to the external charger when the connector of the external charger is inserted, and inputs power supplied from the external charger. The 800 V inlet 22 outputs the inputted power to the battery unit 10 via the charge switching unit 40.

[0017] The main switching unit 30 energizes or interrupts the current flowing between the battery unit 10 and the front PCU 3 and the rear PCU 4. The main switching unit 30 is configured to include a main relay 31, a main relay 32, a main relay 33, and a main relay 34. The main relays 31 to 34 are, for example, an N-channel type metal-oxide-semiconductor field-effect transistor (MOSFET), and energizes or interrupts a current. The main relay 31 is provided between the positive electrode of the first battery 11 and the positive electrode of the front PCU 3. The main relay 31 is turned on by the controller 60 to energize the current flowing from the positive electrode of the first battery 11 to the front PCU 3. The main relay 31 is also turned off by the controller 60 to interrupt the current flowing from the positive electrode of the first battery 11 to the front PCU 3. The main relay 32 is provided between the negative electrode of the second battery 12 and the negative electrode of the front PCU 3. The main relay 32 is turned on by the controller 60 to energize the current flowing from the negative electrode of the second battery 12 to the front PCU 3. The main relay 32 is also turned off by the controller 60 to interrupt the current flowing from the negative electrode of the second battery 12 to the front PCU 3.

[0018] The main relay 33 is provided between the positive electrode of the first battery 11 and the positive electrode of the rear PCU 4. The main relay 33 is turned on by the controller 60 to energize the current flowing from the positive electrode of the first battery 11 to the rear PCU 4. The main relay 33 is also turned off by the controller 60 to interrupt the current flowing from the positive electrode of the first battery 11 to the rear PCU 4. The main relay 34 is provided between the negative electrode of the second battery 12 and the negative electrode of the rear PCU 4. The main relay 34 is turned on by the controller 60 to energize the current flowing from the negative electrode of the second battery 12 to the rear PCU 4. The main relay 34 is also turned off by the controller 60 to interrupt the current flowing from the negative electrode of the second battery 12 to the rear PCU 4.

[0019] The charge switching unit 40 energizes or interrupts the current flowing between the charging inlet 20 and the battery unit 10. The charge switching unit 40 is configured to include a charging relay 41, a parallel-connected relay 51, a charging relay 43, and a charging relay 44. The charging relays 41, 43 and 44, and the parallel-connected relay 51 are, for example, an N-channel type MOSFET, and energizes or interrupts a current.

[0020] The parallel-connected relay 51 is provided between the positive electrode of the first battery 11 and the positive electrode of the 400 V inlet 21. The parallel-connected relay 51 is turned on by the controller 60 to energize the current flowing from the positive electrode of the first battery 11 to the positive electrode of the 400 V inlet 21. The parallel-connected relay 51 is also turned off by the controller 60 to interrupt the current flowing from the positive electrode of the first battery 11 to the positive electrode of the 400 V inlet 21.

[0021] The charging relay 41 is provided between the negative electrodes of the first and second batteries 11 and 12 and the negative electrode of the 400 V inlet 21. The charging relay 41 is turned on by the controller 60 to energize the current flowing from the negative elec-

trodes of the first and second batteries 11 and 12 to the negative electrode of the 400 V inlet 21. The charging relay 41 is also turned off by the controller 60 to interrupt the current flowing from the negative electrodes of the first and second batteries 11 and 12 to the negative electrode of the 400 V inlet 21.

[0022] The charging relay 43 is provided between the positive electrode of the first battery 11 and the positive electrode of the 800 V inlet 22. The charging relay 43 is turned on by the controller 60 to energize the current flowing from the positive electrode of the first battery 11 to the positive electrode of the 800 V inlet 22. The charging relay 43 is also turned off by the controller 60 to interrupt the current flowing from the positive electrode of the first battery 11 to the positive electrode of the 800 V inlet 22.

[0023] The charging relay 44 is provided between the negative electrode of the second battery 12 and the negative electrode of the 800 V inlet 22. The charging relay 44 is turned on by the controller 60 to energize the current flowing from the negative electrode of the second battery 12 to the negative electrode of the 800 V inlet 22. The charging relay 44 is also turned off by the controller 60 to interrupt the current flowing from the negative electrode of the second battery 12 to the negative electrode of the 800 V inlet 22.

[0024] The battery switching unit 50 switches the connection between the first battery 11 and the second battery 12. The battery switching unit 50 is configured to include a parallel-connected relay 51, a parallel-connected relay 52, a parallel-connected relay 53, and a series-connected relay 56.

[0025] The series-connected relay 56 is provided between the positive electrode of the second battery 12 and the negative electrode of the first battery 11. The series-connected relay 56 is turned on by the controller 60 to energize between the positive electrode of the second battery 12 and the negative electrode of the first battery 11. The series-connected relay 56 is also turned off by the controller 60 to interrupt between the positive electrode of the second battery 12 and the negative electrode of the first battery 11.

[0026] The parallel-connected relay 51 is provided between the positive electrode of the first battery 11 and the positive electrode of the 400 V inlet 21. The parallel-connected relay 51 has a first parasitic diode D1, connects a first cathode terminal cd1 of the first parasitic diode D1 to the positive electrode of the first battery 11, and connects a first anode terminal ad1 of the first parasitic diode D1 to the positive electrode of the 400 V inlet 21 and the positive electrode of the second battery 12. The parallel-connected relay 51 is turned on by the controller 60 to energize between the positive electrode of the first battery 11 and both the positive electrode of the 400 V inlet 21 and the positive electrode of the second battery 12. The parallel-connected relay 51 is also turned off by the controller 60 to interrupt between the positive electrode of the first battery 11 and both the positive electrode of the 400 V inlet 21 and the positive electrode of the second battery 12.

[0027] The parallel-connected relay 52 is provided between the positive electrode of the second battery 12 and the positive electrode of the 400 V inlet 21. The parallel-connected relay 52 has a second parasitic diode D2, connects a second cathode terminal cd2 of the second parasitic diode D2 to the positive electrode of the second battery 12, and connects a second anode terminal ad2 of the second parasitic diode D2 to the positive electrode of the 400 V inlet 21 and the positive electrode of the first battery 11. The parallel-connected relay 52 is turned on by the controller 60 to energize between the positive electrode of the second battery 12 and both the positive electrode of the 400 V inlet 21 and the positive electrode of the first battery 11. The parallel-connected relay 52 is also turned off by the controller 60 to interrupt between the positive electrode of the second battery 12 and both the positive electrode of the 400 V inlet 21 and the positive electrode of the first battery 11.

[0028] The parallel-connected relay 53 is provided between the negative electrode of the first battery 11 and the negative electrode of the second battery 12. The parallel-connected relay 53 has a third parasitic diode D3. A third cathode terminal cd3 of the third parasitic diode D3 is connected to the negative electrode of the first battery 11 and connected to the positive electrode of the second battery 12 via the series-connected relay 56. A third anode terminal ad3 of the third parasitic diode D3 is connected to the negative electrode of the second battery 12 and connected to the negative electrode of the 400 V inlet 21 via the charging relay 41. The parallel-connected relay 53 is turned on by the controller 60 to energize between the negative electrode of the first battery 11 and both the negative electrode of the second battery 12 and the negative electrode of the 400 V inlet 21. The parallel-connected relay 53 is also turned off by the controller 60 to interrupt between the negative electrode of the first battery 11 and both the negative electrode of the second battery 12 and the negative electrode of the 400 V inlet 21.

[0029] The battery switching unit 50 switches the parallel-connected relay 51, the parallel-connected relay 52, the parallel-connected relay 53, and the series-connected relay 56 to switch to the series circuit P connecting the first battery 11 and the second battery 12 in series, or to the parallel circuit Q1 connecting the first battery 11 and the second battery 12 in parallel.

[0030] For example, as illustrated in FIG. 3, the battery switching unit 50 turns on the series-connected relay 56 and turns off the parallel-connected relay 51, the parallel-connected relay 52, and the parallel-connected relay 53, thereby forming the series circuit P connecting the first battery 11 and the second battery 12 in series. Further, as illustrated in FIG. 4, the battery switching unit 50 turns on the parallel-connected relay 51, the parallel-connected relay 52, and the parallel-connected relay 53, and turns off the series-connected relay 56, thereby forming

the parallel circuit Q1 connecting the first battery 11 and the second battery 12 in parallel.

[0031] The controller 60 controls the main switching unit 30, the charge switching unit 40, and the battery switching unit 50. The controller 60 is configured to include an electronic circuit mainly composed of a well-known microcomputer including a CPU, a ROM and a RAM constituting a storage unit, and an interface. The controller 60 controls the main switching unit 30 to energize or interrupt the current flowing between the battery unit 10 and both the front PCU 3 and the rear PCU 4. The controller 60 controls the charge switching unit 40 to energize or interrupt the current flowing between the 400 V inlet 21 or the 800 V inlet 22 and the battery unit 10. The controller 60 controls the battery switching unit 50 to switch the connection between the first battery 11 and the second battery 12 to the series circuit P or the parallel circuit Q1.

[0032] The controller 60 is configured to include voltage monitor circuits 61 to 63 (see FIG. 5). The voltage monitor circuit 61 monitors the voltage of the parallel-connected relay 51. The voltage monitor circuit 61 controls the parallel-connected relay 51 based on voltages applied to the first cathode terminal cd1 and the first anode terminal ad1. As illustrated in FIG. 6, the voltage monitor circuit 61 includes a booster circuit 61a, a comparator circuit 61b, and a driver circuit 61c. The booster circuit 61a is connected to the 400 V inlet 21 and the driver circuit 61c, and boosts the driver circuit 61c based on the power supplied from the 400 V inlet 21.

[0033] The comparator circuit 61b outputs the comparison result of the voltage applied between the terminals of the parallel-connected relay 51. The comparator circuit 61b connects the positive electrode terminal to the first anode terminal ad1 of the first parasitic diode D1 and connects a negative electrode terminal to the first cathode terminal cd1 of the first parasitic diode D1. The comparator circuit 61b outputs the comparison result between the voltage applied to the first cathode terminal cd1 and the voltage applied to the first anode terminal ad1 to the driver circuit 61c. For example, when the voltage applied to the first cathode terminal cd1 is less than the voltage applied to the first anode terminal ad1, the comparator circuit 61b outputs an ON signal for turning on the parallel-connected relay 51 to the driver circuit 61c. On the other hand, when the voltage applied to the first cathode terminal cd1 is equal to or higher than the voltage applied to the first anode terminal ad1, the comparator circuit 61b outputs an OFF signal for turning off the parallel-connected relay 51 to the driver circuit 61c.

[0034] The driver circuit 61c turns on or off the parallel-connected relay 51. The driver circuit 61c is connected to the output terminal of the comparator circuit 61b and the gate terminal of the parallel-connected relay 51, and turns on or off the parallel-connected relay 51 based on the comparison result of the comparator circuit 61b. For example, when an ON signal is outputted from the comparator circuit 61b, the driver circuit 61c applies an ON voltage to the gate terminal of the parallel-connected relay 51 to turn on the parallel-connected relay 51. Thus, it is energized between the positive electrode of the first battery 11 and both the positive electrode of the 400 V inlet 21 and the positive electrode of the second battery 12. On the other hand, when an OFF signal is outputted from the comparator circuit 61b, the driver circuit 61c applies an OFF voltage to the gate terminal of the parallel-connected relay 51 to turn off the parallel-connected relay 51. Thus, the positive electrode of the first battery 11, the positive electrode of the 400 V inlet 21 and the positive electrode of the second battery 12 are interrupted.

[0035] As illustrated in FIG. 5, a voltage monitor circuit 62 monitors the voltage of the parallel-connected relay 52. The voltage monitor circuit 62 has the same configuration and operation as the voltage monitor circuit 61. In other words, the voltage monitor circuit 62 controls the parallel-connected relay 52 based on voltages applied to the second cathode terminal cd2 and the second anode terminal ad2. For example, when the voltage applied to the second cathode terminal cd2 is less than the voltage applied to the second anode terminal ad2, the voltage monitor circuit 62 turns on the parallel-connected relay 52 to energize between the positive electrode of the second battery 12 and both the positive electrode of the 400 V inlet 21 and the positive electrode of the first battery 11. On the other hand, when the voltage applied to the second cathode terminal cd2 is equal to or higher than the voltage applied to the second anode terminal ad2, the voltage monitor circuit 62 turns off the parallel-connected relay 52 to interrupt between the positive electrode of the second battery 12 and both the positive electrode of the 400 V inlet 21 and the positive electrode of the first battery 11.

[0036] As illustrated in FIG. 5, the voltage monitor circuit 63 monitors the voltage of the parallel-connected relay 53. As illustrated in FIG. 7, for example, the voltage monitor circuit 63 has an offset power supply 63a, a comparator circuit 63b, an AND circuit 63c, and a driver circuit 63d. The offset power supply 63a is a power supply for applying a predetermined voltage (for example, 10 V) to the positive electrode of the comparator circuit 63b. When the series-connected relay 56 is turned off, the offset power supply 63a applies a predetermined voltage (for example, 10 V) to the side of the third anode terminal ad3 in order to turn on the parallel-connected relay 53, although there is no potential difference between the third cathode terminal cd3 and the third anode terminal ad3 of the parallel-connected relay 53. In other words, the offset power supply 63a applies a predetermined voltage (for example, 10 V) to the side of the third anode terminal ad3 in order to satisfy the condition of turning on, when the potential difference between the third anode terminal ad3 and the third cathode terminal cd3 is zero and the voltage of the third anode terminal ad3 is higher than the voltage of the third cathode terminal cd3.

[0037] The comparator circuit 63b outputs the comparison result of the voltage applied between the terminals

of the parallel-connected relay 53. The comparator circuit 63b connects the positive electrode terminal to the third anode terminal ad3 of the third parasitic diode D3 via the offset power supply 63a and connects the negative electrode terminal to the third cathode terminal cd3 of the third parasitic diode D3. The comparator circuit 63b outputs the comparison result between the voltage applied to the third cathode terminal cd3 and the voltage applied to the third anode terminal ad3 to the AND circuit 63c. For example, when the voltage applied to the third cathode terminal cd3 is less than the voltage applied to the third anode terminal ad3, the comparator circuit 63b outputs an ON signal for turning on the parallel-connected relay 53 to the AND circuit 63c. On the other hand, when the voltage applied to the third cathode terminal cd3 is equal to or higher than the voltage applied to the third anode terminal ad3, the comparator circuit 63b outputs an OFF signal for turning off the parallel-connected relay 53 to the AND circuit 63c.

[0038] The AND circuit 63c is a circuit for calculating the AND of the two signals. The AND circuit 63c calculates an AND of an external signal for turning on or off the parallel-connected relay 53 and an ON signal or an OFF signal outputted from the comparator circuit 63b. The external signal is a signal for preventing a short circuit by making the parallel-connected relay 53 in an OFF state before turning on the series-connected relay 56 when switching from the parallel circuit Q1 to the series circuit P. The AND circuit 63c outputs an ON signal for turning on the parallel-connected relay 53 to the driver circuit 63d when the external signal is an ON and the ON signal is outputted from the comparator circuit 63b. On the other hand, the AND circuit 63c outputs an OFF signal for turning off the parallel-connected relay 53 to the driver circuit 63d when at least one of the external signals and the signal outputted from the comparator circuit 63b is an OFF.

[0039] The driver circuit 63d turns on or off the parallel-connected relay 53. The driver circuit 63d is connected to the output terminal of the AND circuit 63c and the gate terminal of the parallel-connected relay 53, and turns on or off the parallel-connected relay 53 based on the output result of the AND circuit 63c. For example, when an ON signal is outputted from the AND circuit 63c, the driver circuit 63d applies an ON voltage to the gate terminal of the parallel-connected relay 53 to turn on the parallel-connected relay 53. Thus, the positive electrode and the negative electrode of the second battery 12 are energized. On the other hand, when an OFF signal is outputted from the AND circuit 63c, the driver circuit 63d applies an OFF voltage to the gate terminal of the parallel-connected relay 53 to turn off the parallel-connected relay 53. Thus, the positive electrode and the negative electrode of the second battery 12 are interrupted.

[0040] Next, an operation example of 400 V charging of the power supply device 1 will be described. FIG. 8 is a flowchart illustrating an operation example of 400 V charging according to the embodiment. In the power supply device 1, the controller 60 determines whether or not 400 V charging has been started (step S1). For example, when the voltage on the 400 V inlet 21 side is higher than the voltage on the battery unit 10 side in the parallel-connected relays 51 and 52, the controller 60 determines that the connector of the external charger is connected to the 400 V inlet 21 and charging is started. Specifically, when the voltage applied to the first anode terminal ad1 in the voltage monitor circuit 61 is equal to or higher than the voltage applied to the first cathode terminal cd1 and the voltage applied to the second anode terminal ad2 in the voltage monitor circuit 62 is equal to or higher than the voltage applied to the second cathode terminal cd2, the controller 60 determines that charging is started.

[0041] When 400 V charging is started (step S1; Yes), the controller 60 forms the parallel circuit Q1 (step S2). For example, the controller 60 turns on the parallel-connected relay 51, the parallel-connected relay 52 and the parallel-connected relay 53, and turns off the series-connected relay 56, thereby forming the parallel circuit Q1 connecting the first battery 11 and the second battery 12 in parallel.

[0042] Next, the controller 60 determines whether or not the current flows backward from the first battery 11 (step S3). For example, when the voltage applied to the first cathode terminal cd1 in the voltage monitor circuit 61 is equal to or higher than the voltage applied to the first anode terminal ad1, the controller 60 determines that the current flows backward from the first battery 11 (step S3; Yes), and turns off the parallel-connected relay 51 (step S4).

[0043] On the other hand, when the voltage applied to the first cathode terminal cd1 is less than the voltage applied to the first anode terminal ad1, the controller 60 determines that the current does not flow backward from the first battery 11 (step S3; No), and continues to turn on the parallel-connected relay 51.

[0044] Next, the controller 60 determines whether or not the current flows backward from the second battery 12 (step S5). For example, when the voltage applied to the second cathode terminal cd2 in the voltage monitor circuit 62 is equal to or higher than the voltage applied to the second anode terminal ad2, the controller 60 determines that the current flows backward from the second battery 12 (step S5; Yes), and turns off the parallel-connected relay 52 (step S6). On the other hand, when the voltage applied to the second cathode terminal cd2 is less than the voltage applied to the second anode terminal ad2, the controller 60 determines that the current does not flow backward from the second battery 12 (step S5; No), and continues to turn on the parallel-connected relay 52.

[0045] Next, the controller 60 turns on the charge switching unit 40 (step S7). The controller 60, for example, turns on the charging relay 41 to charge the first and second batteries 11 and 12 constituting the parallel circuit Q (step S8). Next, the controller 60 determines whether or not charging has been completed (step S9). The con-

troller 60, when charging is completed (step S9; Yes), turns off the charge switching unit 40 to terminate the 400 V charging process. The controller 60, when charging has not been completed (step S9; No), returns to the above-described step S3 and determines again whether or not the current flows backward from the first battery 11. In the above-described step S1, when the 400 V charging has not started (step S1; No), the controller 60 terminates the 400 V charging process.

[0046] As described above, the power supply device 1 according to the embodiment includes the first battery 11, the second battery 12, the battery switching unit 50, the charging inlet 20, and the controller 60. The first battery 11 is a storage battery mounted on a vehicle and capable of storing electric power. The second battery 12 is a storage battery mounted on said vehicle and capable of storing electric power. The battery switching unit 50 is a circuit capable of switching the series-connected relay 56, the parallel-connected relay 51, the parallel-connected relay 52 and the parallel-connected relay 53 to switch to a series circuit P connecting the first battery 11 and the second battery 12 in series or a parallel circuit Q1 connecting the first battery 11 and the second battery 12 in parallel. The charging inlet 20 is connected to an external charger to input power supplied from the external charger. The controller 60 controls the battery switching unit 50 to switch to the series circuit P or the parallel circuit Q1.

[0047] The series-connected relay 56 is provided between the positive electrode of the second battery 12 and the negative electrode of the first battery 11, and energizes or interrupts between the positive electrode of the second battery 12 and the negative electrode of the first battery 11. The parallel-connected relay 51 has a first parasitic diode D1, connects the first cathode terminal cd1 of the first parasitic diode D1 to the positive electrode of the first battery 11, and connects the first anode terminal ad1 of the first parasitic diode D1 to the positive electrode of the charging inlet 20 to energize or interrupt between the positive electrode of the first battery 11 and the positive electrode of the charging inlet 20. The parallel-connected relay 52 has a second parasitic diode D2, connects the second cathode terminal cd2 of the second parasitic diode D2 to the positive electrode of the second battery 12, and connects the second anode terminal ad2 of the second parasitic diode D2 to the positive electrode of the charging inlet 20 to energize or interrupt between the positive electrode of the second battery 12 and the positive electrode of the charging inlet 20. The parallel-connected relay 53 is provided between the negative electrode of the first battery 11 and the negative electrode of the second battery 12, and energizes or interrupts between the negative electrode of the first battery 11 and the negative electrode of the second battery 12. When charging the first battery 11 and the second battery 12, the controller 60 controls the battery switching unit 50 to switch to the parallel circuit Q1, controls the parallel-connected relay 51 based on the voltages applied to the first cathode terminal cd1 and the first anode terminal ad1, and further controls the parallel-connected relay 52 based on the voltages applied to the second cathode terminal cd2 and the second anode terminal ad2.

[0048] This configuration enables the power supply device 1 to inhibit the current (inrush current) flowing backward from one of the first battery 11 or the second battery 12 to the other when the battery is charged by forming the parallel circuit Q1 in a state where the charging rate of the first battery 11 is different from the charging rate of the second battery 12. In this case, since the power supply device 1 does not need to determine the order of turning on the relays as in the prior art, the complicated operation of the device can be reduced. Since the power supply device 1 reduces the reverse flow by the parallel-connected relays 51 and 52, the loss can be reduced as compared with the case of reducing the reverse flow by the conventional diode. In the power supply device 1, since the parallel-connected relay 51 also functions as a relay for charging, an increase in the number of relays can be suppressed, and an increase in the size of the device can be suppressed. In the power supply device 1, when the series-connected relay 56 is turned on, the voltage of the first cathode terminal cd1 becomes larger than the voltage of the first anode terminal ad1 and the parallel-connected relay 51 is turned off, so that the parallel-connected relay 51 and the series-connected relay 56 can be prevented from being turned on simultaneously and the short circuit of the first battery 11 can be prevented. The power supply device 1 can supply power to a load unit by forming a series circuit P. As a result, the power supply device 1 can be properly charged and discharged.

[0049] In the power supply device 1 described above, when, in charging the first battery 11 and the second battery 12 constituting the parallel circuit Q1, the voltage applied to the first cathode terminal cd1 is less than the voltage applied to the first anode terminal ad1, the controller 60 turns on the parallel-connected relay 51 to energize between the positive electrode of the first battery 11 and the positive electrode of the charging inlet 20. On the other hand, when the voltage applied to the first cathode terminal cd1 is equal to or higher than the voltage applied to the first anode terminal ad1, the controller 60 turns off the parallel-connected relay 51 to interrupt between the positive electrode of the first battery 11 and the positive electrode of the charging inlet 20. Similarly, when the voltage applied to the second cathode terminal cd2 is less than the voltage applied to the second anode terminal ad2, the controller 60 turns on the parallel-connected relay 52 to energize between the positive electrode of the second battery 12 and the positive electrode of the charging inlet 20. On the other hand, when the voltage applied to the second cathode terminal cd2 is equal to or higher than the voltage applied to the second anode terminal ad2, the controller 60 turns off the parallel-connected relay 52 to interrupt between the positive electrode of the second battery 12 and the positive electrode

of the charging inlet 20.

[0050] This configuration enables the power supply device 1 to inhibit the current flowing backward from the positive electrode of the first battery 11 to the positive electrode of the second battery 12, even if the parallel circuit Q1 is formed, for example, when the charging rate of the first battery 11 is higher than the charging rate of the second battery 12. Further, even if the parallel circuit Q1 is formed when the charging rate of the second battery 12 is higher than the charging rate of the first battery 11, the power supply device 1 can inhibit the current flowing backward from the positive electrode of the second battery 12 to the positive electrode of the first battery 11.

[0051] In the power supply device 1 described above, the parallel-connected relay 53 has a third parasitic diode D3, connects the third cathode terminal cd3 of the third parasitic diode D3 to the positive electrode of the second battery 12 via the series-connected relay 56, and connects the third anode terminal ad3 of the third parasitic diode D3 to the negative electrode of the second battery 12. When the voltage applied to the third cathode terminal cd3 is less than the voltage applied to the third anode terminal ad3, the controller 60 turns on the parallel-connected relay 53 to energize between the positive electrode and the negative electrode of the second battery 12. On the other hand, when the voltage applied to the third cathode terminal cd3 is equal to or higher than the voltage applied to the third anode terminal ad3, the controller 60 turns off the parallel-connected relay 53 to interrupt between the positive electrode and the negative electrode of the second battery 12. This configuration enables the power supply device 1 to prevent the second battery 12 from short-circuiting.

Modification

[0052] Next, a modification of the embodiment will be described. In the modification of the embodiment, components equivalent to those of the embodiment are denoted by the same reference numerals, and a detailed description thereof is omitted. FIG. 9 is a schematic diagram illustrating a configuration example of a power supply device 1A according to a modification of the embodiment. The power supply device 1A differs from the power supply device 1 of the embodiment in that the power supply device 1A includes a common inlet 23 corresponding to external chargers having voltages of 400 V and 800 V.

[0053] In the power supply device 1A, the charge switching unit 40 is further configured to include a charging relay 45. The charging relay 45 is provided between the positive electrode of the common inlet 23 and the positive electrode of the second battery 12. The charging relay 45 is turned on by the controller 60 when charging 400 V via the common inlet 23 to energize the current flowing from the positive electrode of the common inlet 23 to the positive electrode of the second battery 12. The charging relay 43 is turned off by the controller 60 when charging 800 V via the common inlet 23 to interrupt the current flowing from the positive electrode of the common inlet 23 to the positive electrode of the second battery 12.

[0054] In the power supply device 1A, the battery switching unit 50 is further configured to include a parallel-connected relay 51a, a parallel-connected relay 52a, and a parallel-connected relay 53. The battery switching unit 50 can switch the parallel-connected relay 51a, the parallel-connected relay 52a, and the parallel-connected relay 53 to switch to a parallel circuit Q2 as a second parallel circuit connecting the first battery 11 and the second battery 12 in parallel. The battery switching unit 50, for example, turns on the parallel-connected relay 51a, the parallel-connected relay 52a, and the parallel-connected relay 53 and turns off the series-connected relay 56, thereby forming the parallel circuit Q2 connecting the first battery 11 and the second battery 12 in parallel.

[0055] When charging the first battery 11 and the second battery 12 at 400 V, the controller 60 controls the battery switching unit 50, charges by one circuit of the parallel circuit Q1 or the parallel circuit Q2, and does not charge by the other circuit of the parallel circuit Q1 or the parallel circuit Q2. For example, when charging the first battery 11 and the second battery 12 at 400 V via the 400 V inlet 21, the controller 60 controls the battery switching unit 50 to form the parallel circuit Q1, charges by the parallel circuit Q1, and does not charge by the circuit of the parallel circuit Q2. On the other hand, when charging the first battery 11 and the second battery 12 at 400 V via the common inlet 23, the controller 60 controls the battery switching unit 50 to form the parallel circuit Q2, charges by the parallel circuit Q2, and does not charge by the circuit of the parallel circuit Q1.

[0056] As described above, in the power supply device 1A according to the modification of the embodiment, the battery switching unit 50 can switch the parallel-connected relay 51a, the parallel-connected relay 52a, and the parallel-connected relay 53 to switch to a parallel circuit Q2 connecting the first battery 11 and the second battery 12 in parallel. When charging the first battery 11 and the second battery 12, the controller 60 controls the battery switching unit 50, charges by one circuit of the parallel circuit Q1 or the parallel circuit Q2 and does not charge by the other circuit of the parallel circuit Q1 or the parallel circuit Q2. Thus, the power supply device 1A may be configured to include a common inlet 23 corresponding to external chargers having voltages of 400 V and 800 V.

[0057] Note that the above description has described an example in which each relay is an N-channel type MOSFET, but is not limited thereto, and other switches may be used.

[0058] The power supply device according to the present embodiment can inhibit a current flowing backward from one of the first battery and the second battery to the other when the battery is charged by forming a parallel circuit in a state where the charging rate of the first battery and the charging rate of the second battery are different, and thus enabling to charge and discharge properly.

[0059] Although the invention has been described with respect to specific embodiments for a complete and clear disclosure, the appended claims are not to be thus limited but are to be construed as embodying all modifications and alternative constructions that may occur to one skilled in the art that fall within the scope of the claims.

Claims

1. A power supply device (1, 1A) comprising:

a first battery (11) mounted on a vehicle and capable of storing electric power;
a second battery (12) mounted on the vehicle and capable of storing electric power;
a switching unit (50) including a series-connected switch (56), a first parallel-connected switch (51), a second parallel-connected switch (52) and a third parallel-connected switch (53), said switching unit (50) being configured to form either one of a series circuit (P) connecting the first battery (11) and the second battery (12) in series and a first parallel circuit (Q1) connecting the first battery (11) and the second battery (12) in parallel;
a first input unit (21) configured to be connected to an external charger and to input electric power supplied from the external charger; and
a controller (60) configured to control the switching unit (50) to switch between the series circuit (P) and the first parallel circuit (Q1), wherein
the series-connected switch (56) is provided between a positive electrode of the second battery (12) and a negative electrode of the first battery (11),
the first parallel-connected switch (51) is provided between a positive electrode of the first battery (11) and a positive electrode of the first input unit (21) and has a first parasitic diode (D1), wherein a first cathode terminal (cd1) of the first parasitic diode (D1) is connected to the positive electrode of the first battery (11), and a first anode terminal (ad1) of the first parasitic diode (D1) is connected to the positive electrode of the first input unit (21),
the second parallel-connected switch (52) is provided between the positive electrode of the second battery (12) and the positive electrode of the first input unit (21) and has a second parasitic diode (D2), wherein a second cathode terminal (cd2) of the second parasitic diode (D2) is connected to the positive electrode of the second battery (12), and a second anode terminal (ad2) of the second parasitic diode (D2) is connected to the positive electrode of the first input unit (21),
the third parallel-connected switch (53) is provided between the negative electrode of the first battery (11) and a negative electrode of the second battery (12), and
when charging the first battery (11) and the second battery (12), the controller (60) is configured to control the switching unit (50) to switch to the first parallel circuit (Q1),
wherein
when, in charging the first battery (11) and the second battery (12), the voltage applied to the first cathode terminal (cd1) is less than the voltage applied to the first anode terminal (ad1), the controller (60) is configured to turn on the first parallel-connected switch (51) to energize between the positive electrode of the first battery (11) and the positive electrode of the first input unit (21),
when the voltage applied to the first cathode terminal (cd1) is equal to or higher than the voltage applied to the first anode terminal (ad1), the controller (60) is configured to turn off the first parallel-connected switch (51) to interrupt a current flowing
between the positive
electrode of the first battery (11) and the positive electrode of the first input unit (21),
when the voltage applied to the second cathode terminal (cd2) is less than the voltage applied to the second anode terminal (ad2), the controller (60) is configured to turn on the second parallel-connected switch (52) to energize between the positive electrode of the second battery (12) and the positive electrode of the first input unit (21), and
when the voltage applied to the second cathode terminal (cd2) is equal to or higher than the voltage applied to the second anode terminal (ad2), the controller (60) is configured to turn off the second parallel-connected switch (52) to interrupt a current flowing between
the positive electrode of the second battery (12) and the positive electrode of the first input unit (21).

2. The power supply device (1, 1A) according to claim 1, wherein
the third parallel-connected switch (53) has a third parasitic diode (D3), a third cathode terminal (cd3) of the third parasitic diode (D3) is connected to the positive electrode of the second battery (12) via the series-connected switch (56), and a third anode terminal (ad3) of the third parasitic diode (D3) is connected to the negative electrode of the second battery (12),

when a voltage applied to the third cathode terminal (cd3) is less than a voltage applied to the third anode terminal (ad3), the controller (60) is

configured to turn on the third parallel-connected switch (53) to energize between the positive electrode and the negative electrode of the second battery (12), and

when the voltage applied to the third cathode terminal (cd3) is equal to or higher than the voltage applied to the third anode terminal (ad3), the controller (60) is configured to turn off the third parallel-connected switch (53) to interrupt a current flowing between the positive electrode and the negative electrode of the second battery (12).

3. The power supply device (1A) according to claim 1 or 2, further comprising a second input unit (23) configured to be connected to an external charger and to input electric power supplied from the external charger,

wherein the switching unit (50) further comprises a fourth parallel-connected switch (51a), a fifth parallel-connected switch (52a), and the third parallel-connected switch (53) to form a second parallel circuit (Q2) connecting the first battery (11) and the second battery (12) in parallel, and

wherein the fourth parallel-connected switch (51a) is provided between a positive electrode of the first battery (11) and a positive electrode of the second input unit (23) and has a fourth parasitic diode, wherein a first cathode terminal of the fourth parasitic diode is connected to the positive electrode of the first battery (11), and a first anode terminal of the fourth parasitic diode is connected to the positive electrode of the second input unit (23),

wherein the fifth parallel-connected switch (52a) is provided between the positive electrode of the second battery (12) and the positive electrode of the second input unit (23) and has a fifth parasitic diode, wherein a second cathode terminal of the fifth parasitic diode is connected to the positive electrode of the second battery (12), and a second anode terminal of the fifth parasitic diode is connected to the positive electrode of the second input unit (23),

when charging the first battery (11) and the second battery (12), the controller (60) is configured to control the switching unit (50), to charge by one circuit of the first parallel circuit (Q1) or the second parallel circuit (Q2), and to not charge by another circuit of the first parallel circuit (Q1) or the second parallel circuit (Q2).

Patentansprüche

1. Stromversorgungsvorrichtung (1, 1A), die umfasst:

eine erste Batterie (11), die an einem Fahrzeug angebracht ist und elektrische Energie speichern kann;

eine zweite Batterie (12), die an dem Fahrzeug angebracht ist und elektrische Energie speichern kann;

eine Schalt-Einheit (50), die einen in Reihe geschalteten Schalter (56), einen ersten parallel geschalteten Schalter (51), einen zweiten parallel geschalteten Schalter (52) und einen dritten parallel geschalteten Schalter (53) enthält, wobei die Schalt-Einheit (50) so ausgeführt ist, dass sie entweder eine Reihenschaltung (P), die die erste Batterie (11) und die zweite Batterie (12) in Reihe verbindet, oder eine erste Parallelschaltung (Q1) bildet, die die erste Batterie (11) und die zweite Batterie (12) parallel verbindet;

eine erste Einleit-Einheit (21), die so ausgeführt ist, dass sie an eine externe Ladeeinrichtung angeschlossen wird und von der externen Ladeeinrichtung zugeführte elektrische Energie einleitet; sowie

eine Steuerungseinrichtung (60), die so ausgeführt ist, dass sie die Schalt-Einheit (50) so steuert, dass sie zwischen der Reihenschaltung (P) und der ersten Parallelschaltung (Q1) umschaltet, wobei

der in Reihe geschaltete Schalter (56) zwischen einer positiven Elektrode der zweiten Batterie (12) und einer negativen Elektrode der ersten Batterie (11) vorhanden ist,

der erste parallel geschaltete Schalter (51) zwischen einer positiven Elektrode der ersten Batterie (11) und einer positiven Elektrode der ersten Einleit-Einheit (21) vorhanden ist und eine erste parasitäre Diode (D1) aufweist, wobei ein erster Kathodenanschluss (cd1) der ersten parasitären Diode (D1) mit der positiven Elektrode der ersten Batterie (11) verbunden ist, und ein erster Anodenanschluss (ad1) der ersten parasitären Diode (D1) mit der positiven Elektrode der ersten Einleit-Einheit (21) verbunden ist,

der zweite parallel geschaltete Schalter (52) zwischen der positiven Elektrode der zweiten Batterie (12) und der positiven Elektrode der ersten Einleit-Einheit (21) vorhanden ist und eine zweite parasitäre Diode (D2) aufweist, wobei ein zweiter Kathodenanschluss (cd2) der zweiten parasitären Diode (D2) mit der positiven Elektrode der zweiten Batterie (12) verbunden ist, und ein zweiter Anodenanschluss (ad2) der zweiten parasitären Diode (D2) mit der positiven Elektrode der ersten Einleit-Einheit (21) verbunden ist,

der dritte parallel geschaltete Schalter (53) zwischen der negativen Elektrode der ersten Batterie (11) und einer negativen Elektrode der

zweiten Batterie (12) vorhanden ist, und
die Steuerungseinrichtung (60) so ausgeführt ist, dass sie die Schalt-Einheit (50) beim Laden der ersten Batterie (11) und der zweiten Batterie (12) so steuert, dass sie auf die erste Parallelschaltung (Q1) umschaltet,
wobei
die Steuerungseinrichtung (60) so ausgeführt ist, dass sie, wenn beim Laden der ersten Batterie (11) und der zweiten Batterie (12) die an den ersten Kathodenanschluss (cd1) angelegte Spannung niedriger ist als die an den ersten Anodenanschluss (ad1) angelegte Spannung, den ersten parallel geschalteten Schalter (51) schließt, um zwischen der positiven Elektrode der ersten Batterie (11) und der positiven Elektrode der ersten Einleit-Einheit (21) Spannung anzulegen,
die Steuerungseinrichtung (60) so ausgeführt ist, dass sie, wenn die an den ersten Kathodenanschluss (cd1) angelegte Spannung genauso hoch ist wie oder höher als die an den ersten Anodenanschluss (ad1) angelegte Spannung, den ersten parallel geschalteten Schalter (51) öffnet, um einen zwischen der positiven Elektrode der ersten Batterie (11) und der positiven Elektrode der ersten Einleit-Einheit (21) fließenden Strom zu unterbrechen,
die Steuerungseinrichtung (60) so ausgeführt ist, dass sie, wenn die an den zweiten Kathodenanschluss (cd2) angelegte Spannung niedriger ist als die an den zweiten Anodenanschluss (ad2) angelegte Spannung, den zweiten parallel geschalteten Schalter (52) schließt, um zwischen der positiven Elektrode der zweiten Batterie (12) und der positiven Elektrode der ersten Einleit-Einheit (21) Spannung anzulegen, und
die Steuerungseinrichtung (60) so ausgeführt ist, dass sie, wenn die an den zweiten Kathodenanschluss (cd2) angelegte Spannung genauso hoch ist wie oder höher als die an den zweiten Anodenanschluss (ad2) angelegte Spannung, den zweiten parallel geschalteten Schalter (52) öffnet, um einen zwischen der positiven Elektrode der zweiten Batterie (12) und der positiven Elektrode der ersten Einleit-Einheit (21) fließenden Strom zu unterbrechen.

2. Stromversorgungsvorrichtung (1, 1A) nach Anspruch 1, wobei

der dritte parallel geschaltete Schalter (53) eine dritte parasitäre Diode (D3) aufweist, ein dritter Kathodenanschluss (cd3) der dritten parasitären Diode (D3) über den in Reihe geschalteten Schalter (56) mit der positiven Elektrode der zweiten Batterie (12) verbunden ist, und ein dritter Anodenanschluss (ad3) der dritten parasitären Diode (D3) mit der negativen Elektrode der zweiten Batterie (12) verbunden ist,
die Steuerungseinrichtung (60) so ausgeführt ist, dass sie, wenn eine an den dritten Kathodenanschluss (cd3) angelegte Spannung niedriger ist als eine an den dritten Anodenanschluss (ad3) angelegte Spannung, den dritten parallel geschalteten Schalter (53) schließt, um zwischen der positiven Elektrode und der negativen Elektrode der zweiten Batterie (12) Spannung anzulegen, und
die Steuerungseinrichtung (60) so ausgeführt ist, dass sie, wenn die an den dritten Kathodenanschluss (cd3) angelegte Spannung genauso hoch ist wie oder höher als die an den dritten Anodenanschluss (ad3) angelegte Spannung, den dritten parallel geschalteten Schalter (53) öffnet, um einen zwischen der positiven Elektrode und der negativen Elektrode der zweiten Batterie (12) fließenden Strom zu unterbrechen.

3. Stromversorgungsvorrichtung (1A) nach Anspruch 1 oder 2, die des Weiteren umfasst:

eine zweite Einleit-Einheit (23), die so ausgeführt ist, dass sie an eine externe Ladeeinrichtung angeschlossen wird und von der externen Ladeeinrichtung zugeführte elektrische Energie einleitet,
wobei die Schalt-Einheit (50) des Weiteren einen vierten parallel geschalteten Schalter (51a), einen fünften parallel geschalteten Schalter (52a) und den dritten parallel geschalteten Schalter (53) umfasst, die eine zweite Parallelschaltung (Q2) bilden, die die erste Batterie (11) und die zweite Batterie (12) parallel verbindet, und
der vierte parallel geschaltete Schalter (51a) zwischen einer positiven Elektrode der ersten Batterie (11) und einer positiven Elektrode der zweiten Einleit-Einheit (23) vorhanden ist und eine vierte parasitäre Diode aufweist, wobei ein erster Kathodenanschluss der vierten parasitären Diode mit der positiven Elektrode der ersten Batterie (11) verbunden ist, und ein erster Anodenanschluss der vierten parasitären Diode mit der positiven Elektrode der zweiten Einleit-Einheit (23) verbunden ist,
der fünfte parallel geschaltete Schalter (52a) zwischen der positiven Elektrode der zweiten Batterie (12) und der positiven Elektrode der zweiten Einleit-Einheit (23) vorhanden ist und eine fünfte parasitäre Diode aufweist, wobei ein zweiter Kathodenanschluss der fünften parasitären Diode mit der positiven Elektrode der zweiten Batterie (12) verbunden ist, und ein zweiter Anodenanschluss der fünften parasitären Diode mit der positiven Elektrode der zweiten Einleit-

Einheit (23) verbunden ist,
die Steuerungseinrichtung (60) so ausgeführt ist, dass sie beim Laden der ersten Batterie (11) und der zweiten Batterie (12) die Schalt-Einheit (50) so steuert, dass sie über einen Stromkreis der ersten Parallelschaltung (Q1) oder der zweiten Parallelschaltung (Q2) lädt und über einen anderen Stromkreis der ersten Parallelschaltung (Q1) oder der zweiten Parallelschaltung (Q2) nicht lädt.

Revendications

1. Dispositif d'alimentation électrique (1, 1A) comprenant :

une première batterie (11) montée sur un véhicule et pouvant stocker de l'énergie électrique ;
une seconde batterie (12) montée sur le véhicule et pouvant stocker de l'énergie électrique ;
une unité de commutation (50) comprenant un commutateur connecté en série (56), un premier commutateur connecté en parallèle (51), un deuxième commutateur connecté en parallèle (52) et un troisième commutateur connecté en parallèle (53), ladite unité de commutation (50) étant configurée pour former soit un circuit série (P) connectant la première batterie (11) et la seconde batterie (12) en série, soit un premier circuit parallèle (Q1) connectant la première batterie (11) et la seconde batterie (12) en parallèle ;
une première unité d'entrée (21) configurée pour être connectée à charge extérieure et pour alimenter en entrée l'énergie électrique fournie depuis le chargeur extérieur ; et
un contrôleur (60) configuré pour contrôler l'unité de commutation (50) pour commuter entre le circuit série (P) et le premier circuit parallèle (Q1), dans lequel
le commutateur connecté en série (56) est situé entre une électrode positive de la seconde batterie (12) et une électrode négative de la première batterie (11),
le premier commutateur connecté en parallèle (51) est situé entre une électrode positive de la première batterie (11) et une électrode positive de la première unité d'entrée (21) et comprend une première diode parasite (D1), dans lequel une première borne de cathode (cd1) de la première diode parasite (D1) est connectée à l'électrode positive de la première batterie (11), et une première borne d'anode (ad1) de la première diode parasite (D1) est connectée à l'électrode positive de la première unité d'entrée (21),
le deuxième commutateur connecté en parallèle (52) est situé entre l'électrode positive de la seconde batterie (12) et l'électrode positive de la première unité d'entrée (21) et comprend une deuxième diode parasite (D2), dans lequel une deuxième borne de cathode (cd2) de la deuxième diode parasite (D2) est connectée à l'électrode positive de la seconde batterie (12), et une deuxième borne d'anode (ad2) de la deuxième diode parasite (D2) est connectée à l'électrode positive de la première unité d'entrée (21),
le troisième commutateur connecté en parallèle (53) est situé entre l'électrode négative de la première batterie (11) et une électrode négative de la seconde batterie (12), et
lors du chargement de la première batterie (11) et de la seconde batterie (12), le contrôleur (60) est configuré pour contrôler l'unité de commutation (50) pour commuter vers le premier circuit parallèle (Q1),
dans lequel
lorsque, pendant le chargement de la première batterie (11) et de la seconde batterie (12), la tension appliquée à la première borne de cathode (cd1) est inférieure à la tension appliquée à la première borne d'anode (ad1), le contrôleur (60) est configuré pour activer le premier commutateur connecté en parallèle (51) pour faire circuler un courant entre l'électrode positive de la première batterie (11) et l'électrode positive de la première unité d'entrée (21),
lorsque la tension appliquée à la première borne de cathode (cd1) est égale ou supérieure à la tension appliquée à la première borne d'anode (ad1), le contrôleur (60) est configuré pour désactiver le premier commutateur connecté en parallèle (51) pour interrompre la circulation d'un courant entre l'électrode positive de la première batterie (11) et l'électrode positive de la première unité d'entrée (21),
lorsque la tension appliquée à la deuxième borne de cathode (cd2) est inférieure à la tension appliquée à la deuxième borne d'anode (ad2), le contrôleur (60) est configuré pour activer le deuxième commutateur connecté en parallèle (52) pour faire circuler un courant entre l'électrode positive de la seconde batterie (12) et l'électrode positive de la première unité d'entrée (21), et
lorsque la tension appliquée à la deuxième borne de cathode (cd2) est égale ou supérieure à la tension appliquée à la deuxième borne d'anode (ad2), le contrôleur (60) est configuré pour désactiver le deuxième commutateur connecté en parallèle (52) pour interrompre la circulation d'un courant entre l'électrode positive de la seconde batterie (12) et l'électrode positive de la première unité d'entrée (21).

2. Dispositif d'alimentation électrique (1, 1A) selon la

revendication 1, dans lequel

le troisième commutateur connecté en parallèle (53) comprend une troisième diode parasite (D3), une troisième borne de cathode (cd3) de la troisième diode parasite (D3) est connectée à l'électrode positive de la seconde batterie (12) par l'intermédiaire du commutateur connecté en série (56), et une troisième borne d'anode (ad3) de la troisième diode parasite (D3) est connectée à l'électrode négative de la seconde batterie (12),
lorsqu'une tension appliquée à la troisième borne de cathode (cd3) est inférieure à une tension appliquée à la troisième borne d'anode (ad3), le contrôleur (60) est configuré pour activer le troisième commutateur connecté en parallèle (53) pour faire circuler un courant entre l'électrode positive et l'électrode négative de la seconde batterie (12), et
lorsque la tension appliquée à la troisième borne de cathode (cd3) est égale ou supérieure à la tension appliquée à la troisième borne d'anode (ad3), le contrôleur (60) est configuré pour désactiver le troisième commutateur connecté en parallèle (53) pour interrompre la circulation d'un courant entre l'électrode positive et l'électrode négative de la seconde batterie (12).

3. Dispositif d'alimentation électrique (1A) selon la revendication 1 ou 2, comprenant en outre

une seconde unité d'entrée (23) configurée pour être connectée à un chargeur extérieur et pour alimenter en entrée l'énergie électrique fournie depuis le chargeur extérieur,
dans lequel l'unité de commutation (50) comprend en outre un quatrième commutateur connecté en parallèle (51a), un cinquième commutateur connecté en parallèle (52a), et le troisième commutateur connecté en parallèle (53) pour former un second circuit parallèle (Q2) connectant la première batterie (11) et la seconde batterie (12) en parallèle, et
dans lequel le quatrième commutateur connecté en parallèle (51a) est situé entre une électrode positive de la première batterie (11) et une électrode positive de la seconde unité d'entrée (23) et comprend une quatrième diode parasite, dans lequel une première borne de cathode de la quatrième diode parasite est connectée à l'électrode positive de la première batterie (11), et une première borne d'anode de la quatrième diode parasite est connectée à l'électrode positive de la seconde unité d'entrée (23),
dans lequel le cinquième commutateur connecté en parallèle (52a) est situé entre l'électrode positive de la seconde batterie (12) et l'électrode positive de la seconde unité d'entrée (23) et comprend une cinquième diode parasite, dans lequel une deuxième borne de cathode de la cinquième diode parasite est connectée à l'électrode positive de la seconde batterie (12), et une deuxième borne d'anode de la cinquième diode parasite est connectée à l'électrode positive de la seconde unité d'entrée (23),
lors du chargement de la première batterie (11) et de la seconde batterie (12), le contrôleur (60) est configuré pour contrôler l'unité de commutation (50), pour faire effectuer la charge par un circuit des premier circuit parallèle (Q1) ou second circuit parallèle (Q2), et pour ne pas faire effectuer la charge par un autre circuit des premier circuit parallèle (Q1) ou second circuit parallèle (Q2).

FIG.1

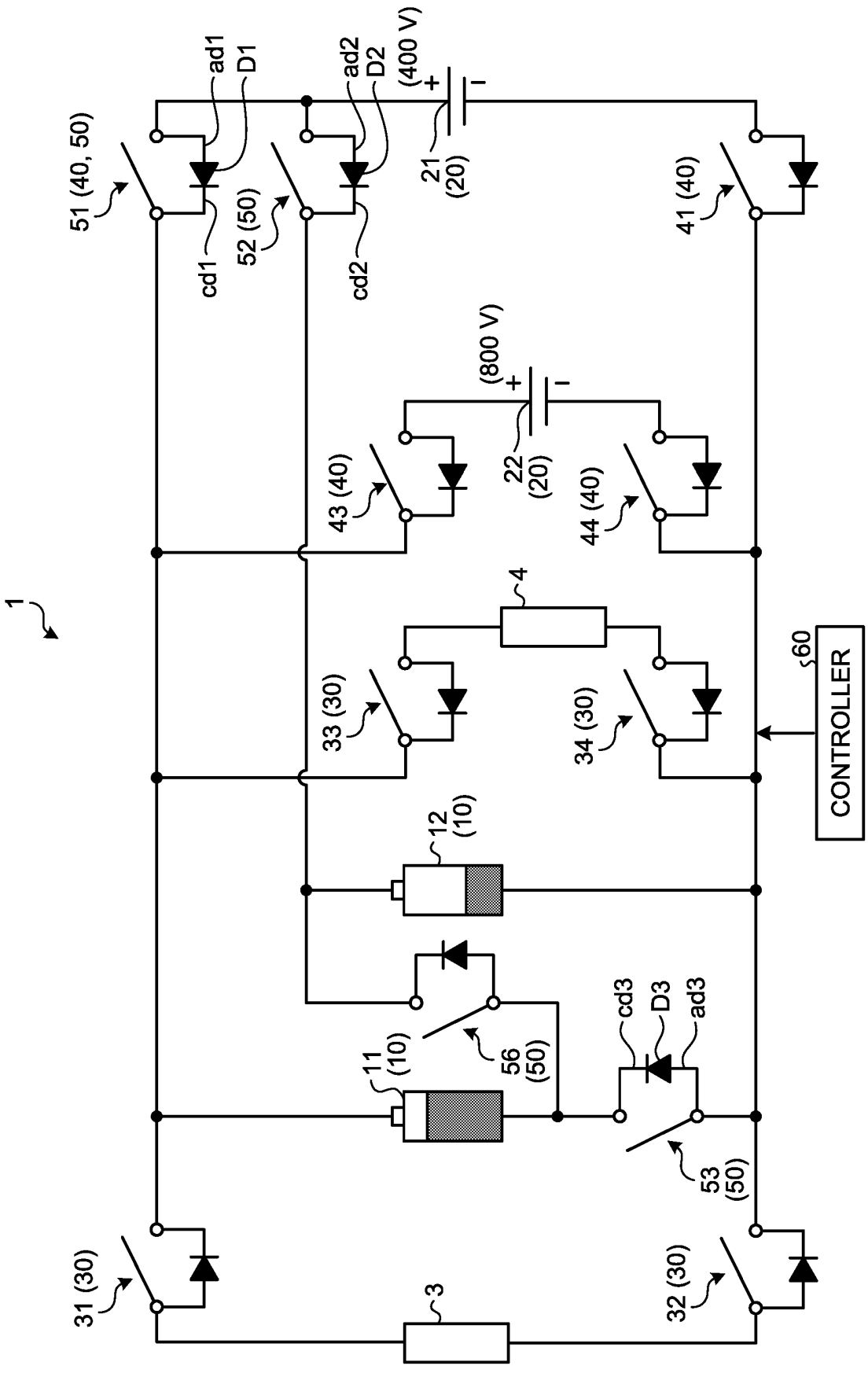

1
51 (40, 50)
ad1
D1
cd1
52 (50)
ad2
D2
cd2
(400 V)
+
−
21
(20)
41 (40)
(800 V)
+
−
22
(20)
43 (40)
44 (40)
4
33 (30)
34 (30)
60
CONTROLLER
12
(10)
11
(10)
56
(50)
cd3
D3
ad3
53
(50)
31 (30)
3
32 (30)

FIG.2

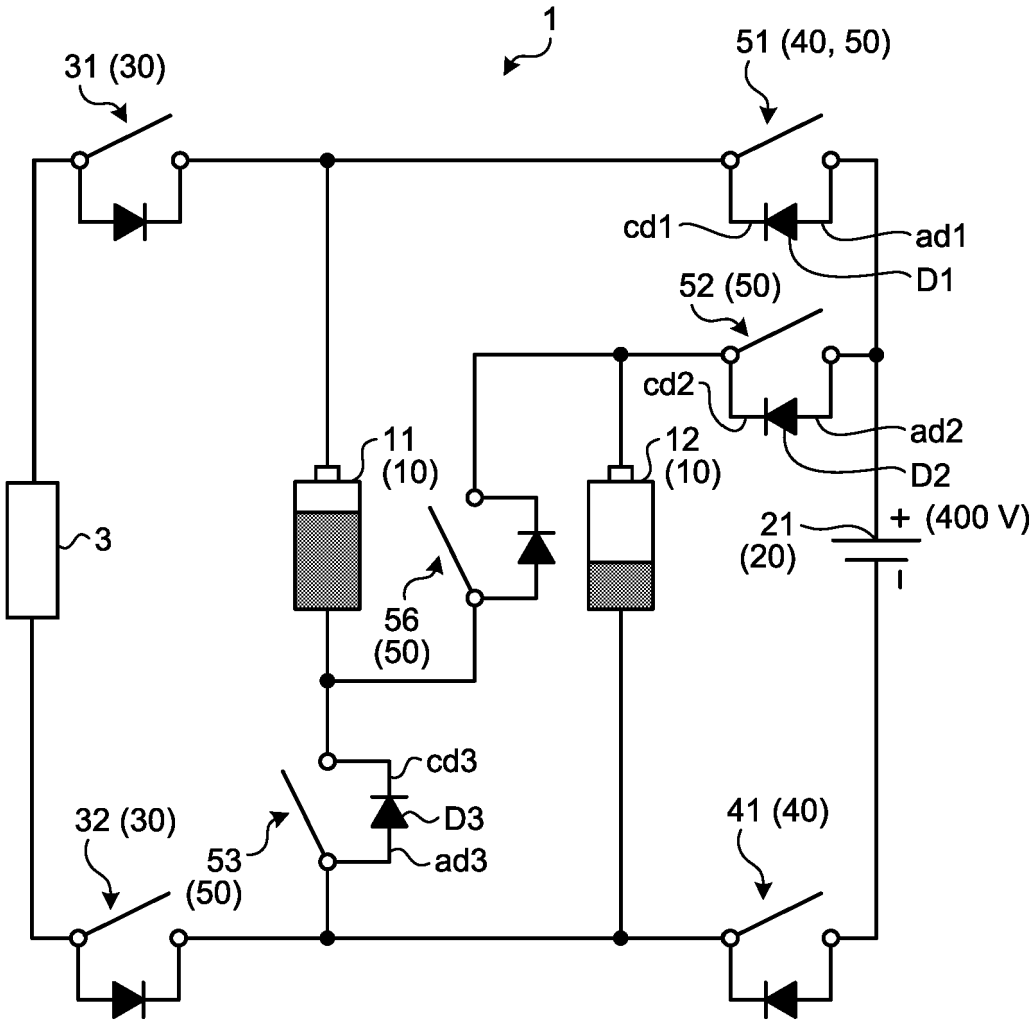

1
31 (30)
51 (40, 50)
cd1
ad1
D1
52 (50)
cd2
ad2
D2
11
(10)
12
(10)
3
21
(20)
+ (400 V)
56
(50)
cd3
D3
ad3
32 (30)
53
(50)
41 (40)

FIG.3

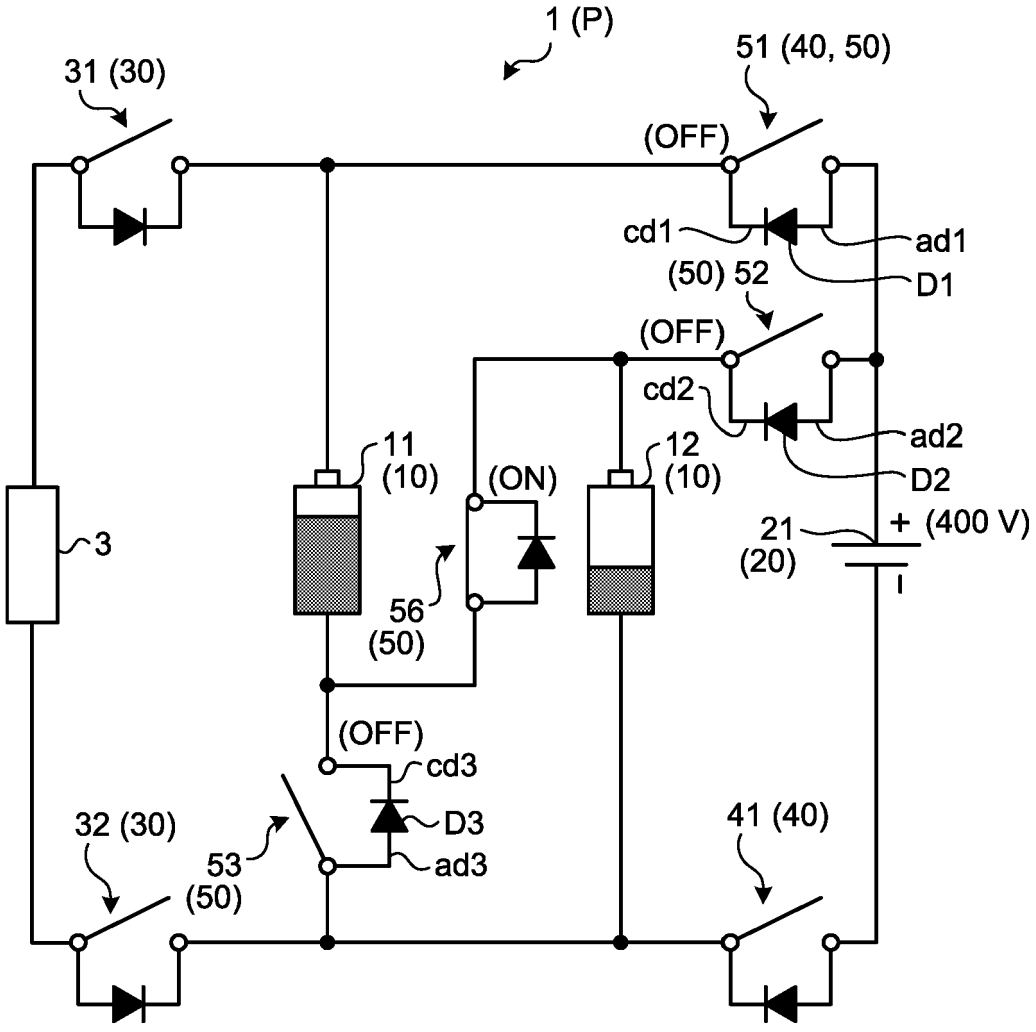

1 (P)
31 (30)
51 (40, 50)
(OFF)
cd1
ad1
D1
(50) 52
(OFF)
cd2
ad2
D2
11
(10)
(ON)
12
(10)
21
(20)
+ (400 V)
3
56
(50)
(OFF)
cd3
D3
ad3
32 (30)
53
(50)
41 (40)

FIG.4

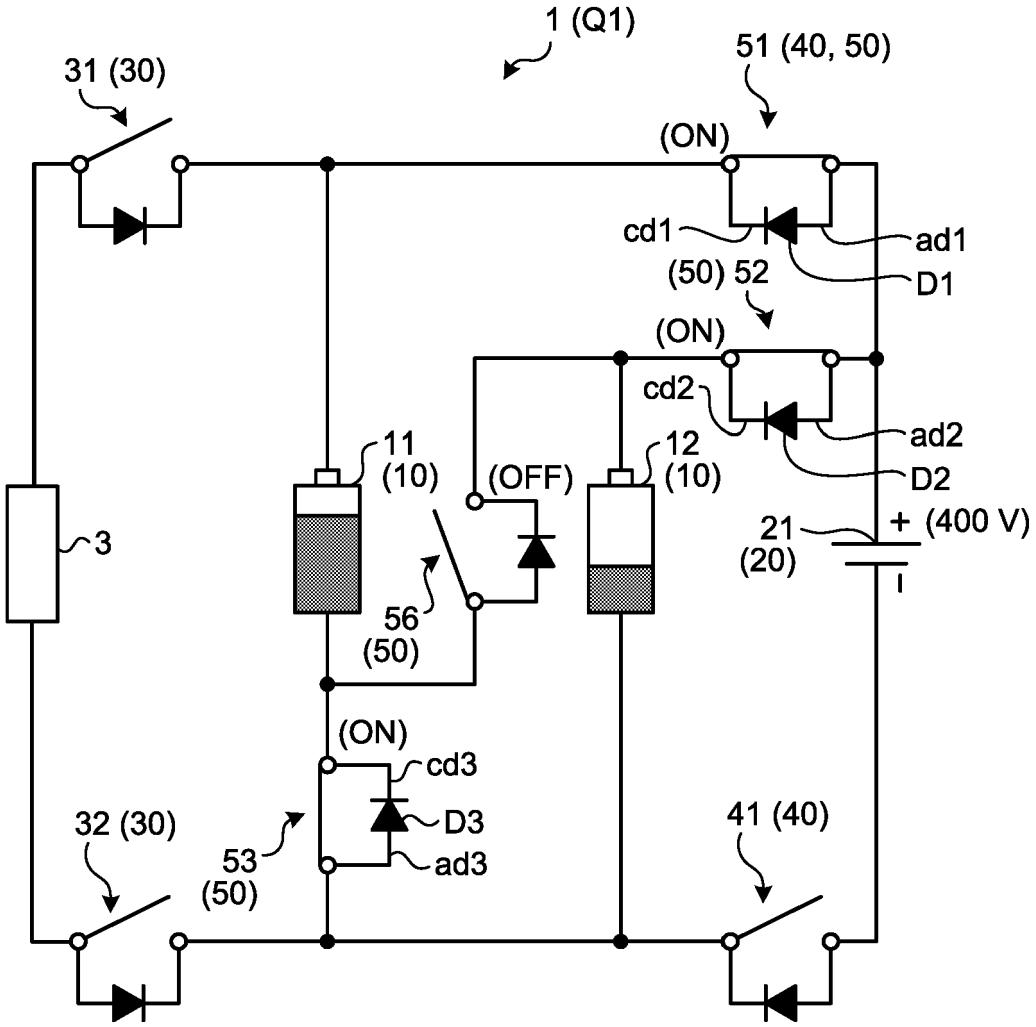

1 (Q1)
31 (30)
51 (40, 50)
(ON)
cd1
ad1
D1
(50) 52
(ON)
cd2
ad2
D2
11
(10)
(OFF)
12
(10)
21
(20)
+ (400 V)
3
56
(50)
(ON)
cd3
D3
ad3
32 (30)
53
(50)
41 (40)

FIG.5

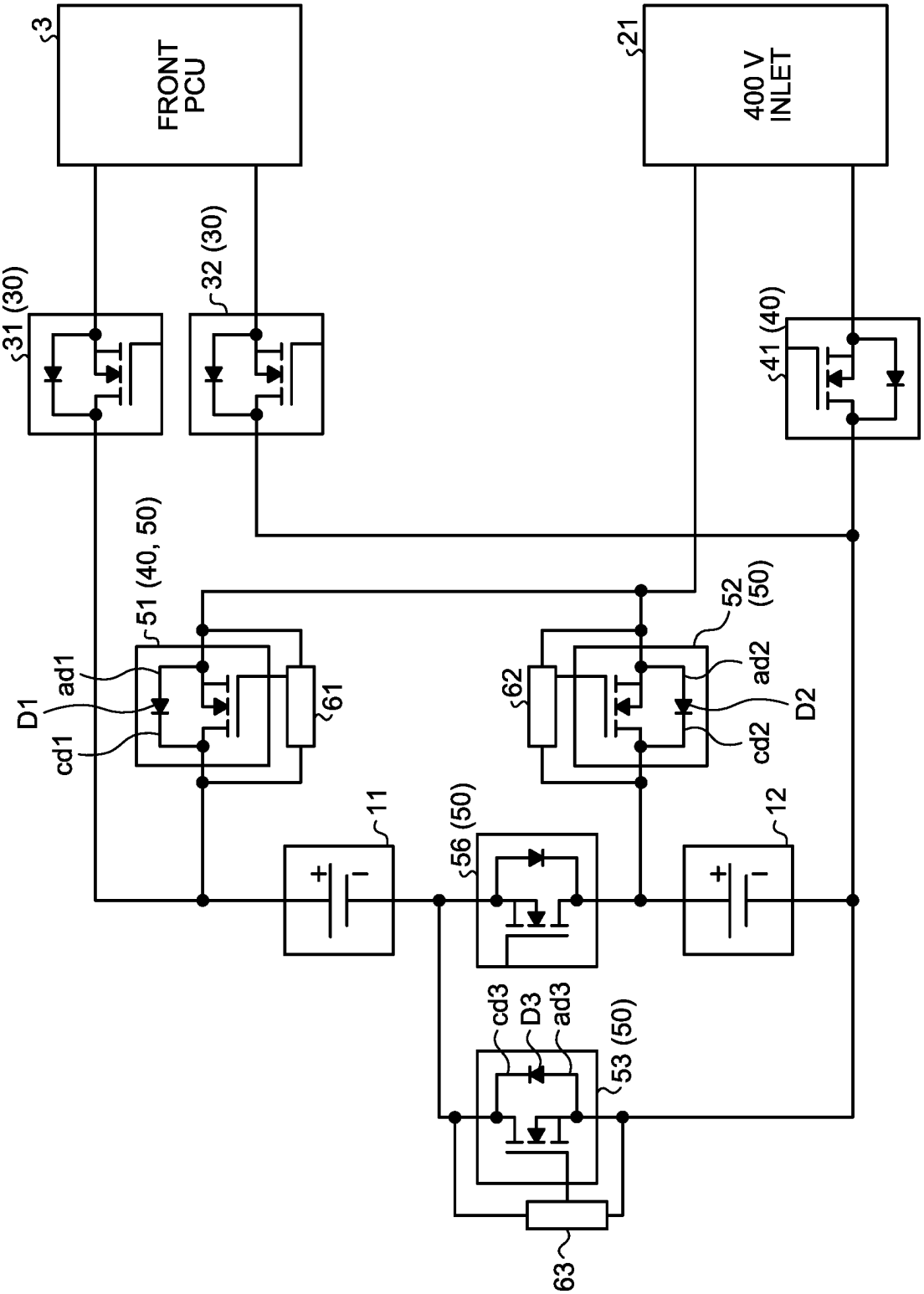

3
FRONT PCU
21
400 V INLET
31 (30)
32 (30)
41 (40)
51 (40, 50)
52 (50)
D1
ad1
cd1
61
62
ad2
D2
cd2
11
12
56 (50)
cd3
D3
ad3
53 (50)
63

FIG.6

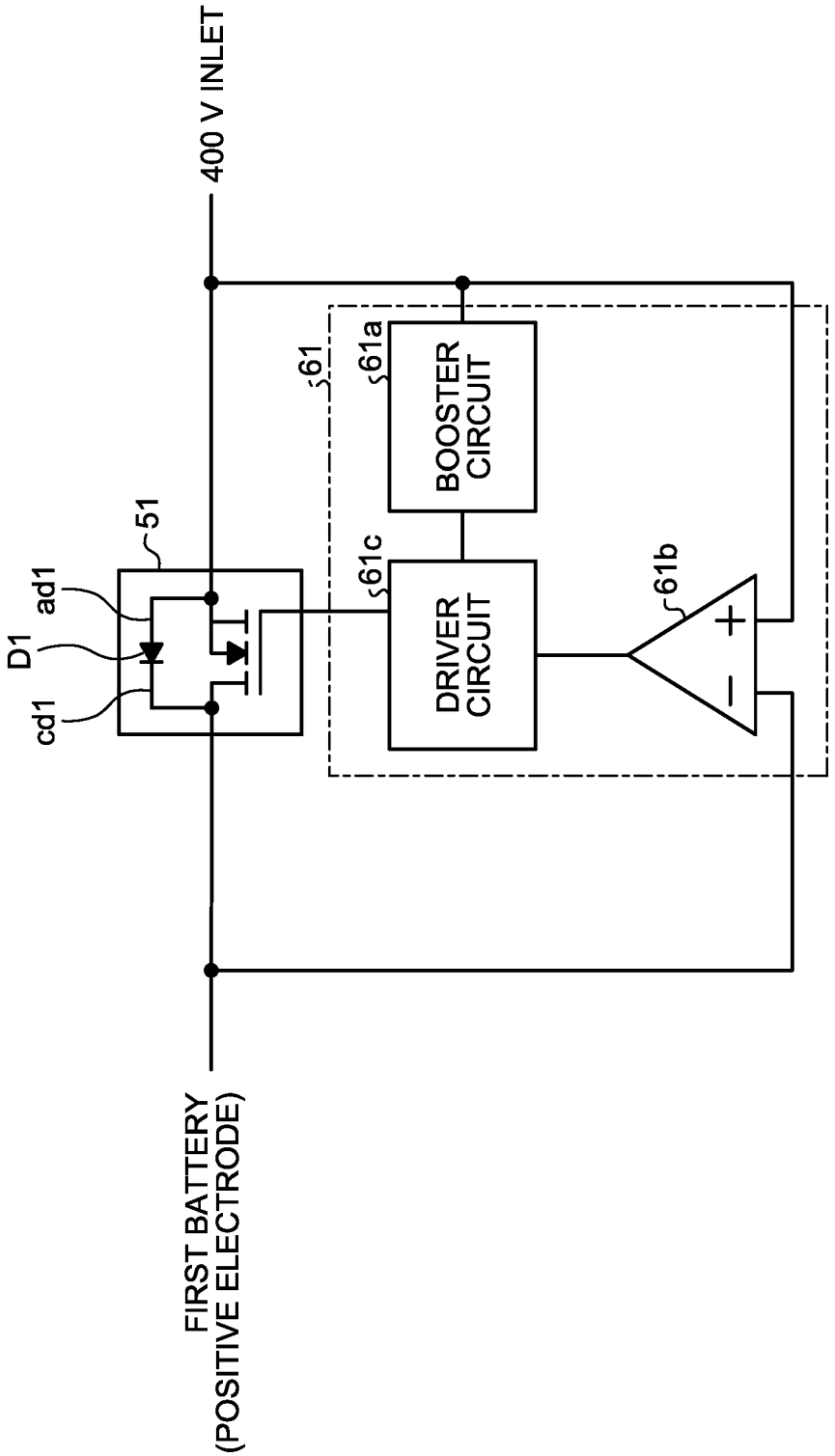

400 V INLET
61
61a
BOOSTER CIRCUIT
61c
DRIVER CIRCUIT
61b
51
ad1
D1
cd1
FIRST BATTERY (POSITIVE ELECTRODE)

FIG.7

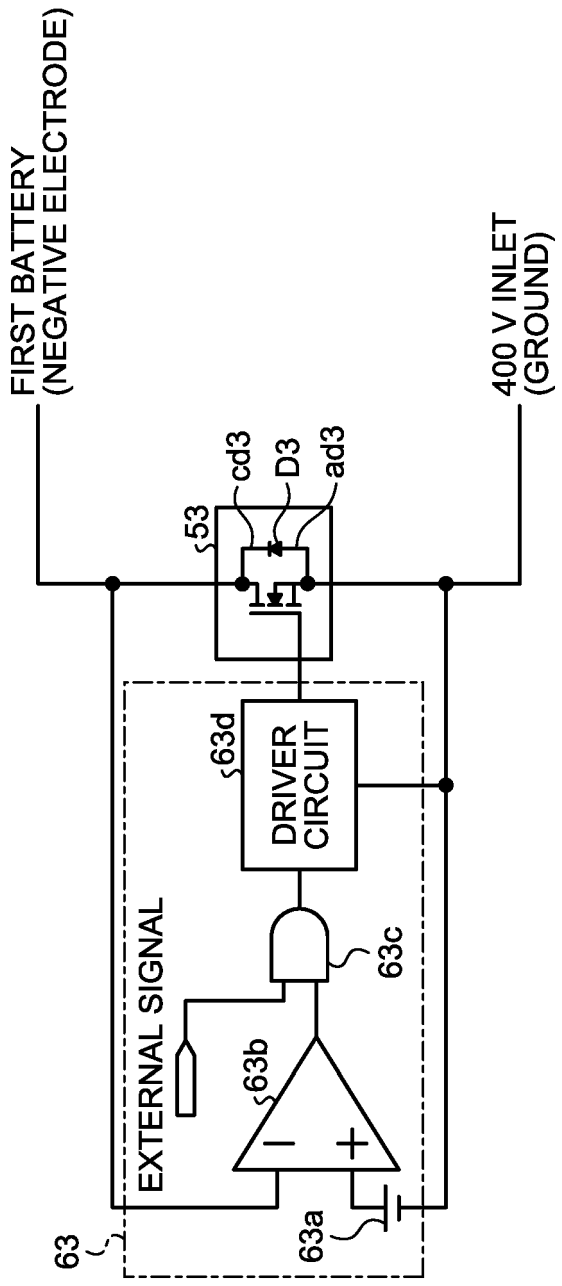

FIRST BATTERY
(NEGATIVE ELECTRODE)
400 V INLET
(GROUND)
53
cd3
D3
ad3
63d
DRIVER
CIRCUIT
63c
63b
EXTERNAL SIGNAL
63
63a

FIG.8

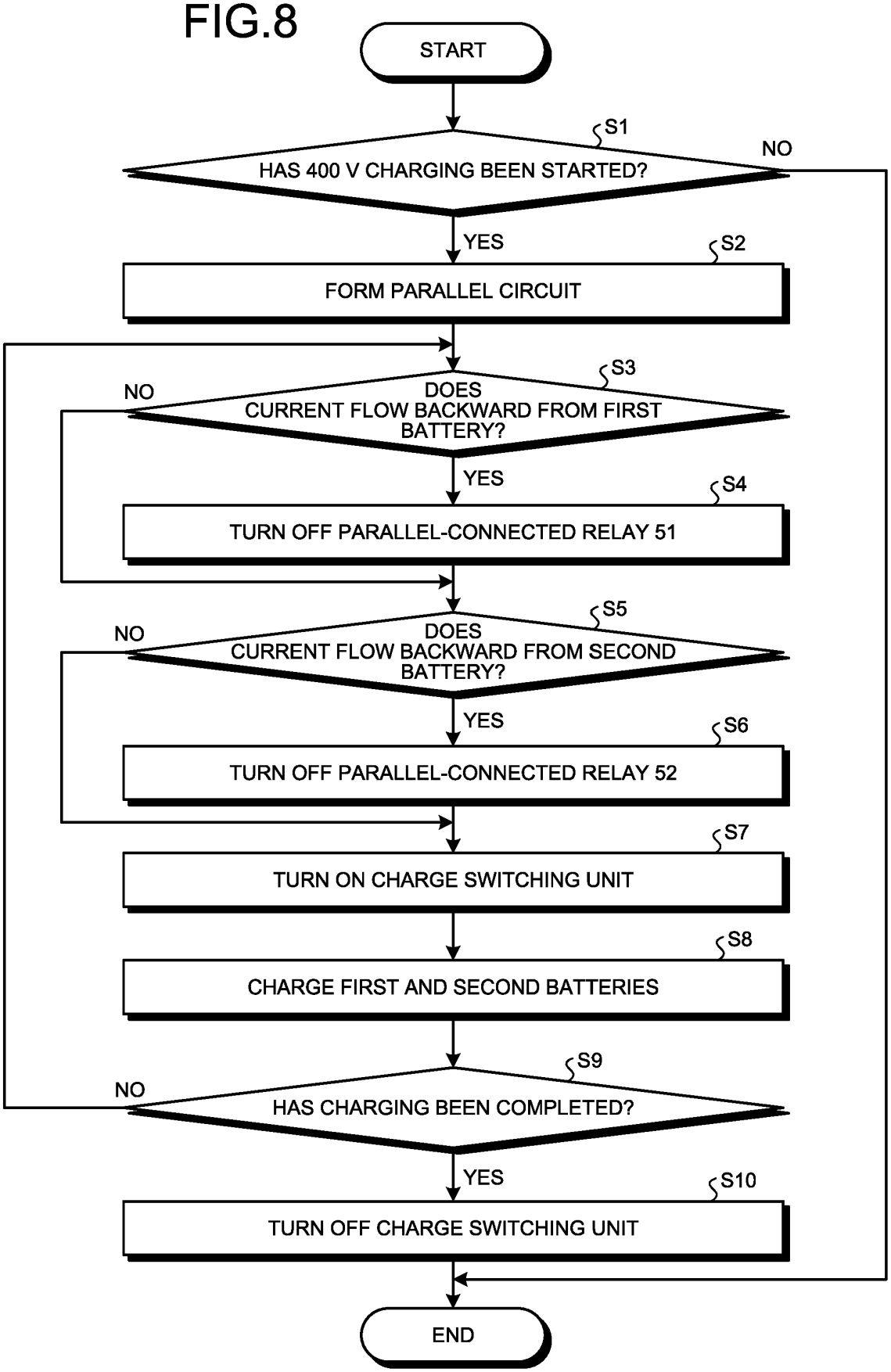
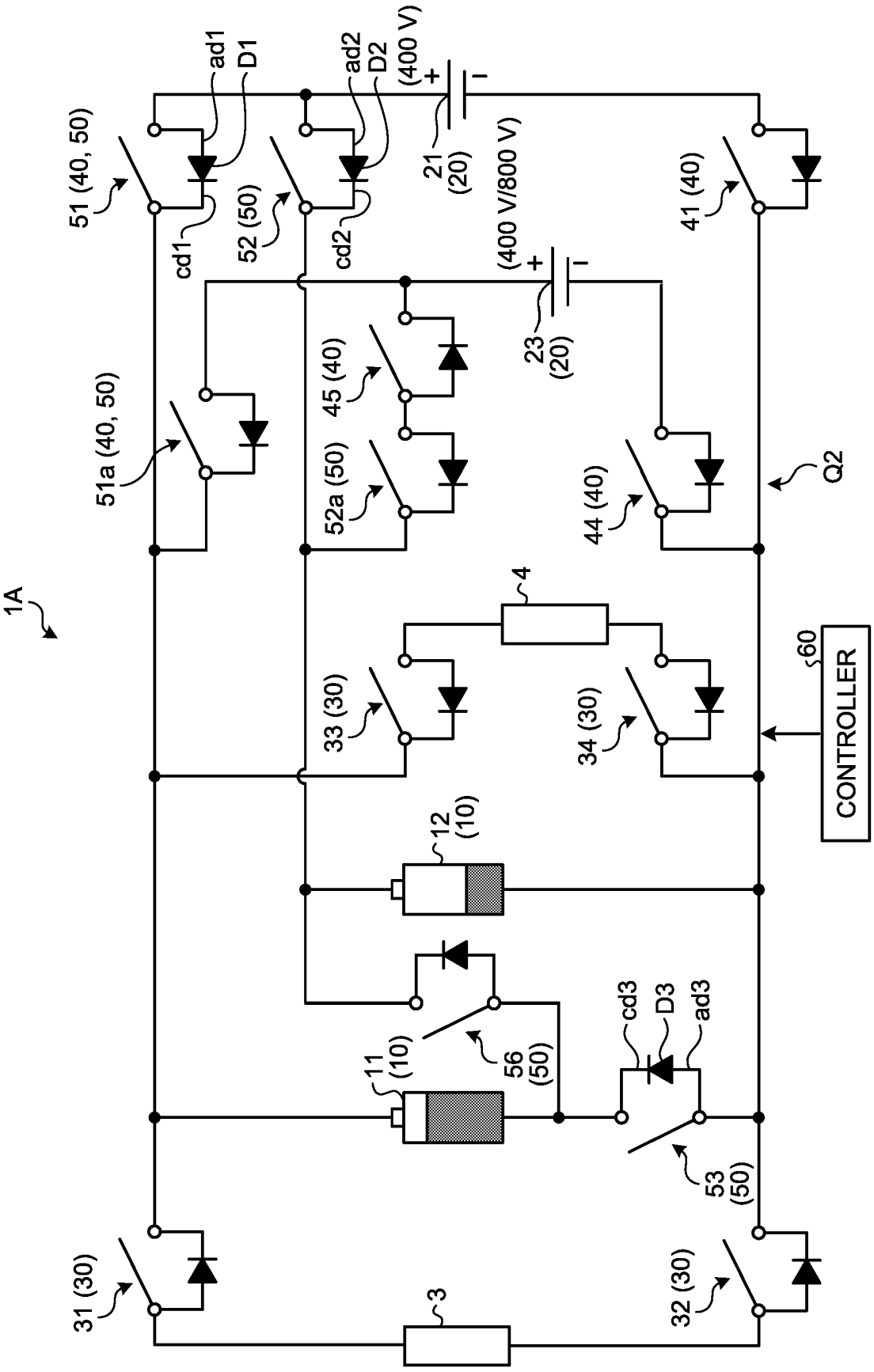

START
S1
HAS 400 V CHARGING BEEN STARTED?
NO
YES
S2
FORM PARALLEL CIRCUIT
S3
DOES CURRENT FLOW BACKWARD FROM FIRST BATTERY?
NO
YES
S4
TURN OFF PARALLEL-CONNECTED RELAY 51
S5
DOES CURRENT FLOW BACKWARD FROM SECOND BATTERY?
NO
YES
S6
TURN OFF PARALLEL-CONNECTED RELAY 52
S7
TURN ON CHARGE SWITCHING UNIT
S8
CHARGE FIRST AND SECOND BATTERIES
S9
HAS CHARGING BEEN COMPLETED?
NO
YES
S10
TURN OFF CHARGE SWITCHING UNIT
END

FIG.9


1A
51 (40, 50)
ad1
D1
cd1
52 (50)
ad2
D2
cd2
(400 V)
21 (20)
(400 V/800 V)
23 (20)
41 (40)
45 (40)
52a (50)
51a (40, 50)
44 (40)
Q2
4
33 (30)
34 (30)
60
CONTROLLER
12 (10)
11 (10)
56 (50)
cd3
D3
ad3
53 (50)
31 (30)
3
32 (30)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2018033263 A **[0002] [0003]**
- DE 102016008052 A1 **[0004]**